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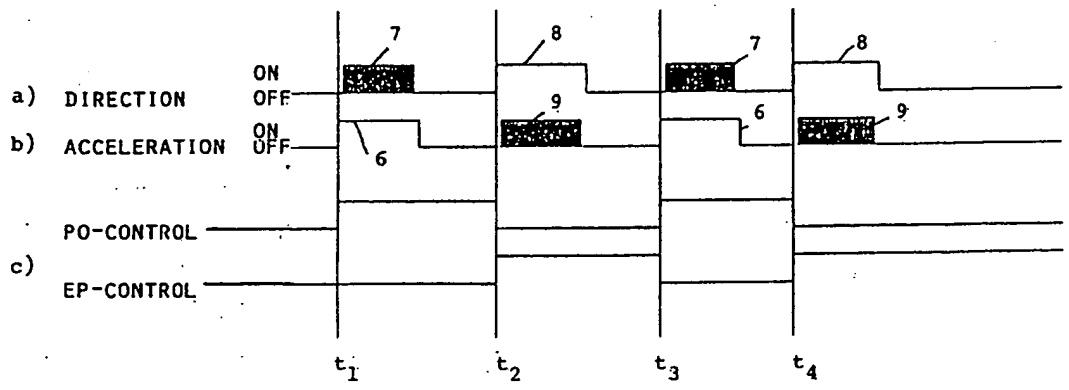
(54) Procedure for controlling the motor of a crane.

(57) The invention relates to a procedure for selecting the mode of controlling the motor of a crane or an equivalent lifting apparatus. At least two alternative modes of controlling the motor are available, at least one of the modes involving control by means of a switch having at least two positions connectable in a certain order, producing corresponding control signals in the control port, while each control mode uses at least one control signal common to all modes. According to the invention, the signals (6-9) applied to the control port are monitored, the prevailing control situation is determined on the basis of the signals (6-9) monitored and the mode of control is selected on the basis of the signals (6-9) and the prevailing control situation.

FIG. 3



EP 0 491 200 A1

The pr sent invention relates to a procedure for selecting the mode of control of the motor of a crane or an equivalent lifting apparatus, as defined in the introductory part of claim 1.

It is often necessary to be able to control the motor of a crane or an equivalent lifting apparatus from several locations. In this case, care must be taken that only one control location is active at a time and that an operation once started can be completed without being influenced by another operator.

The motor is generally controlled by means of push-button controllers which select the direction, the length of time during which the push-button switch is closed determining the speed reference for the motor control system. Another alternative is the joystick controller, in which the joystick position determines the direction on the one hand and the speed reference value on the other hand. The push-button controller is used e.g. in hanging controllers, which are located near the load to be lifted, whereas the joystick controller is commonly used in the control cabin of a crane.

The mode of operation is selected by means of a separate selection switch, which can be placed e.g. in the control cabin. In addition to the switch, the cabin must be provided with appropriate wiring for the selection signal, and the motor drive must be provided with an extra input for this purpose.

The object of the present invention is to achieve a system permitting the selection of the control mode without the use of a separate switch and associated wiring and thus to produce a simpler and more reliable connection. The procedure of the invention is characterized by the features defined in the chracterization part of claim 1. Other embodiments are presented in the subclaims.

In the following, the invention is described in detail by the aid of examples of its embodiments by referring to the drawings attached, in which

Fig. 1 presents a motor control system in which the procedure of the invention is applied,

Fig. 2 presents the flow diagram of the procedure of the invention, and

Fig. 3 presents a timing diagram for motor control according to the invention.

As shown in Fig. 1, the motor 2 of the lifting apparatus 1 is controlled by means of a control unit 3. The control unit 3 is fed from the mains (not shown) and it converts the supply voltage into a form (a.c. / d.c.) suited for the motor type and causes the motor to behave in accordance with the control commands issued. The lifting apparatus is controlled by means of two controllers 4 and 5, which are normally used to control the horizontal and vertical motions of the crane. The motions in each direction are controlled by separate joysticks, push-buttons or equivalent.

The first controller 4 is implemented using potentiometer control (PO control), in which case the operator's control is a stepl ss movable control device or controller, e.g. a joystick. The control port of the control unit has three inputs connected to the operator's control device. These are for the first and second direction signals, obtained when the control device is turned to the first and second directions respectively, and for an analog speed reference signal, which is proportional to the control device angle. The speed reference may vary e.g. between 0 - 10, corresponding to a speed range of 0 - 100 % of the maximum speed. The analog reference may also contain a component determining the direction of motion, in which case its range of variation could be e.g. -10 - 10 V, corresponing to a speed range of -100 % - 100 %.

The second controller is a push-button controller based on so-called electronic potentiometer control (EP control). For each direction of crane motion - up, down, forward, backward, right, left - the controller has a separate push-button used to control the speed and duration of the motion in the direction concerned. The push-buttons used in crane drive systems are generally of the two-position type, in which the first position determines the start of motion in the direction in question and a so-called initial acceleration as well as the maintenance of the velocity at the level attained. The second position determines the increasing of the speed reference at a given rate of acceleration until the maximum speed is reached. Releasing the push-button causes the motor to decelerate in a controlled manner down to zero speed.

In the control mode used by controller 4, the speed reference acceleration input is always activated first and the controller position always corresponds to the value of the speed reference. In the control mode used by controller 5, the switch determining the direction is always turned on first and only then can the speed reference acceleration be connected. The control unit 3 is provided with a monitoring element which senses the order in which the control unit inputs are switched on, i.e. whether the acceleration input in the control port is on when one of the direction inputs is switched on. Fig. 2 shows a flow diagram illustrating the selection of control mode.

If the speed is other than zero, operation continues in the control mode currently in use. If the speed is zero and the acceleration input is on but the direction inputs off, the control mode of the first controller is selected. Similarly, if a direction input is on and the acceleration off, the control mode of the second controller is selected. In other cases, the current control mode is maintained. Thus, the control mode is selected making use of the order in which the control signals obtained from the con-

trollers are switched on, without using a separate selection switch. The selection logic and the monitoring of th signal states can be implemented in a manner known in itself using techniques belonging to the expertise of a person skilled in the art.

Fig. 3 presents a timing diagram illustrating the selection of control mode when control commands are given in different ways. Curves a) and b) represent the variation of the control signals with respect to time while the curves under c) represent the selection of the control mode on the basis of the control signals in accordance with the selection logic described above. A direction signal 7 issued afterwards while the motor is already running does not affect the control mode. At instant t_2, the direction signal 8 is on but the acceleration is zero, so electronic potentiometer control is selected. Correspondingly, in this case a subsequent acceleration signal 9 has no effect on the control mode.

In this procedure it is naturally necessary to take care that all the controllers and controller positions in each control device are included in the selection process. This prevents simultaneous use of the controller at one control point for a lifting movement and another controller e.g. for a traversing motion.

In the foregoing, the invention has been described by referring to some of its embodiments. However, this presentation should not be regarded as restricting the invention, but the scope of the patent may vary within the limits defined in the following claims.

Claims

1. Procedure for selecting the mode of control of a crane motor (2) when at least two alternative modes of controlling the motor (2) are available, at least one of the modes involving control by means of a switch (5) having at least two positions connectable in a certain order, producing corresponding control signals in the control port, and each control mode using at least one control signal common to all modes, **characterized** in that
   - the signals (6-9) applied to the control port are monitored,
   - the prevailing control situation is determined on the basis of the signals (6-9) monitored, and
   - the mode of control is selected on the basis of the signals (6-9) and the prevailing situation in the control.

2. Procedure according to claim 1, **characterized** in that the control situation is determined on the basis of the temporal order of the signals characteristic of the control modes.

3. Procedure according to claim 1 or 2, in which the first position of at least one two-position switch (5) determines the direction of rotation of the motor while the second position determines the acceleration, the signal determining the acceleration being common to two control modes, **characterized** in that
   - the control port determining the direction of rotation as well as the control port determining the acceleration are monitored and
   - the first control mode is selected if the control signal (7,8) determining the direction of rotation becomes active first and the second control mode is selected in other cases.

4. Procedure according to claim 1, 2 or 3, **characterized** in that the control mode is not changed while the motor (2) is rotating.

5. Procedure according to any one of claims 1 - 4, **characterized** in that the first control mode is electronically controlled stepless variation of speed and the second control mode is analog stepless variation of speed.

FIG. 1

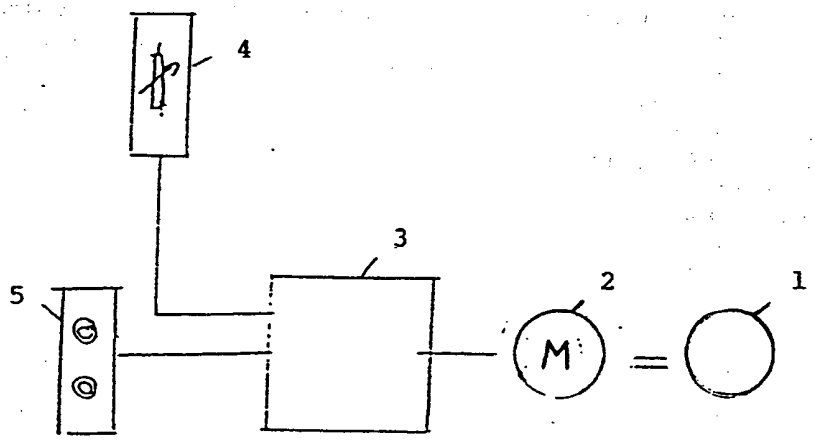
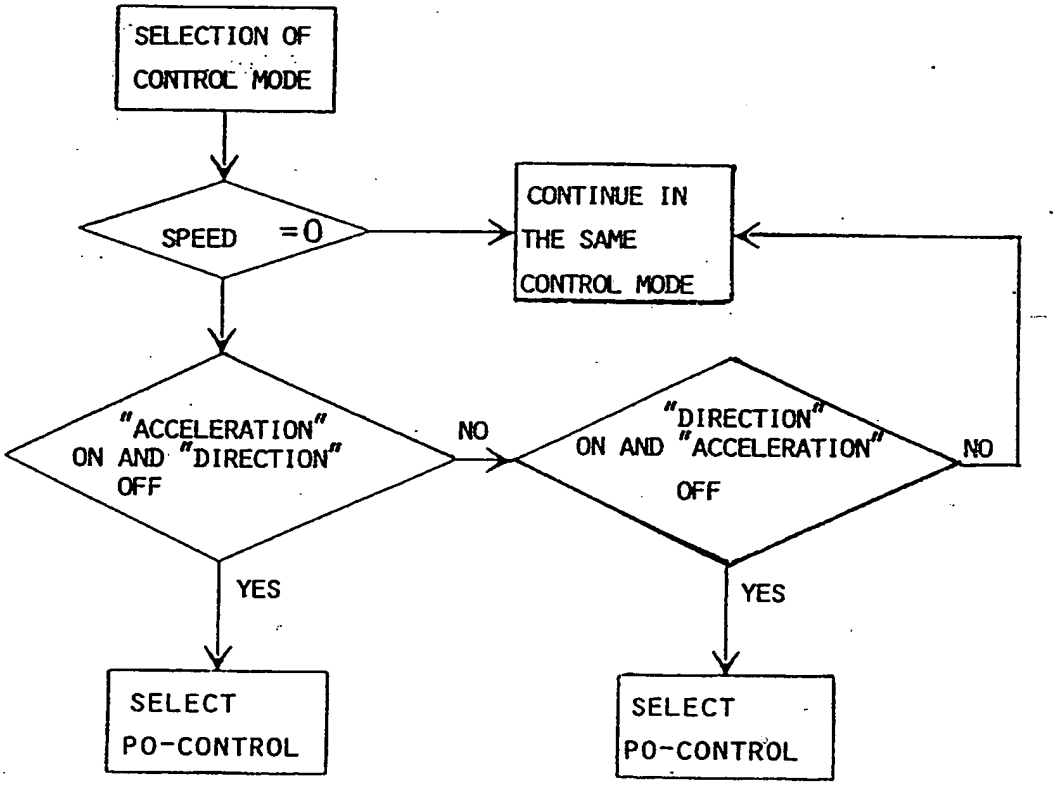
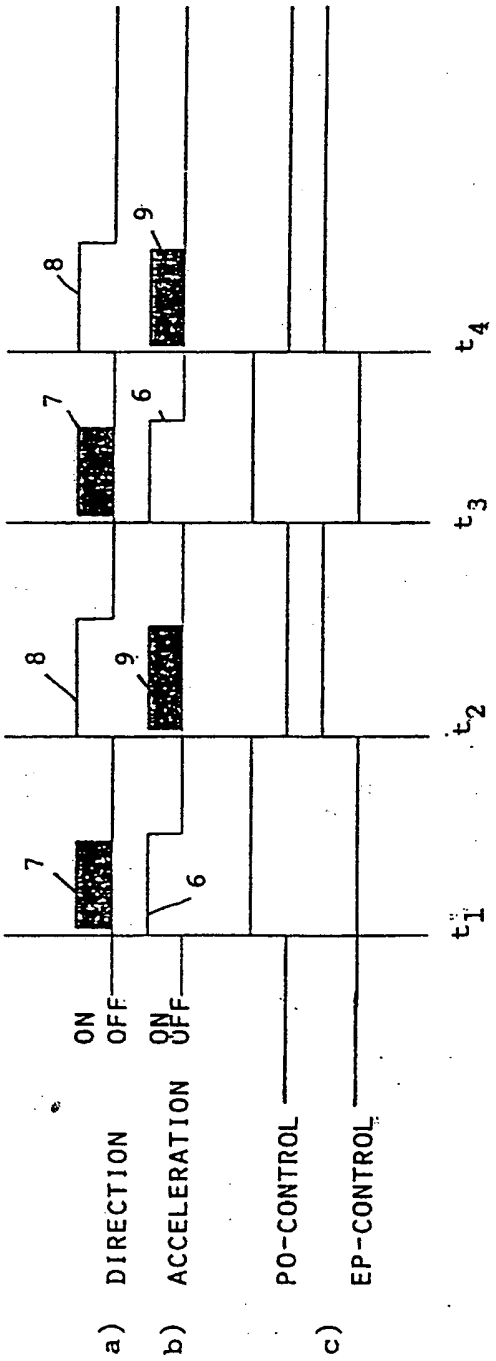


FIG. 2


SELECTION OF CONTROL MODE
SPEED =0
CONTINUE IN THE SAME CONTROL MODE
"ACCELERATION" ON AND "DIRECTION" OFF
NO
"DIRECTION" ON AND "ACCELERATION" OFF
NO
YES
YES
SELECT PO-CONTROL
SELECT PO-CONTROL

FIG, 3


a) DIRECTION
ON
OFF
b) ACCELERATION
ON
OFF
PO-CONTROL
c) EP-CONTROL
6
7
8
9
t1
t2
t3
t4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 12 0508

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 456 132 (D. R. LAVALLE AND P. A. MCLAIN) * column 3, line 61 - column 5, line 8; figures 1,2 *	1	B66C13/22
A	GB-A-2 130 330 (FMC CORPORATION) * claims 1-3; figures 1,2 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B66C
H02P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 MARCH 1992	CHLOSTA P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

(19) Europäisches Patentamt
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(22) Date of filing: **29.11.1991**

(54) Procedure for controlling the motor of a crane

Verfahren zur Kontrolle des Motors eines Krans

Procédé pour contrôler le moteur d'une grue

(84) Designated Contracting States:
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(30) Priority: **17.12.1990 FI 906226**

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(56) References cited:
GB-A- 2 130 330
US-A- 4 456 132

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2.9.9/3.4

Description

The present invention relates to a procedure for selecting the mode of control of the motor of a crane or an equivalent lifting apparatus, as defined in the introductory part of claim 1.

It is often necessary to be able to control the motor of a crane or an equivalent lifting apparatus from several locations. In this case, care must be taken that only one control location is active at a time and that an operation once started can be completed without being influenced by another operator.

The motor is generally controlled by means of push-button controllers which select the direction, the length of time during which the push-button switch is closed determining the speed reference for the motor control system. Another alternative is the joystick controller, in which the joystick position determines the direction on the one hand and the speed reference value on the other hand. The push-button controller is used e.g. in hanging controllers, which are located near the load to be lifted, whereas the joystick controller is commonly used in the control cabin of a crane.

According to GB-A 2 130 330 and US-4 456 132 the mode of operation is selected by means of a separate selection switch, which can be placed e.g. in the control cabin. In addition to the switch, the cabin must be provided with appropriate wiring for the selection signal, and the motor drive must be provided with an extra input for this purpose.

If the selection switch is only provided in the cabin, the operator may forget to operate the selection switch when he leaves his cabin to perform further control from an extern controller. This is very time-consuming. If, on the other hand, each controller is provided with a selection switch a rather complicated wiring and control logic has to be provided which raise the costs of the control system.

The object of the present invention is to achieve a system permitting the selection of the control mode without the use of a separate switch and associated wiring and thus to produce a simpler and more reliable connection. The procedure of the invention is characterized by the features defined in the characterization part of claim 1. Other embodiments are presented in the subclaims.

In the following, the invention is described in detail by the aid of examples of its embodiments by referring to the drawings attached, in which

Fig. 1 presents a motor control system in which the procedure of the invention is applied,

Fig. 2 presents the flow diagram of the procedure of the invention, and

Fig. 3 presents a timing diagram for motor control according to the invention.

As shown in Fig. 1, the motor 2 of the lifting apparatus 1 is controlled by means of a control unit 3. The control unit 3 is fed from the mains (not shown) and it converts the supply voltage into a form (a.c. / d.c.) suited for the motor type and causes the motor to behave in accordance with the control commands issued. The lifting apparatus is controlled by means of two controllers 4 and 5, which are normally used to control the horizontal and vertical motions of the crane. The motions in each direction are controlled by separate joysticks, push-buttons or equivalent.

The first controller 4 is implemented using potentiometer control (PO control), in which case the operator's control is a stepless movable control device or controller, e.g. a joystick. The control port of the control unit has three inputs connected to the operator's control device. These are for the first and second direction signals, obtained when the control device is turned to the first and second directions respectively, and for an analog speed reference signal, which is proportional to the control device angle. The speed reference may vary e.g. between 0 - 10, corresponding to a speed range of 0 - 100 % of the maximum speed. The analog reference may also contain a component determining the direction of motion, in which case its range of variation could be e.g. -10 - 10 V, corresponing to a speed range of -100 % - 100 %.

The second controller is a push-button controller based on so-called electronic potentiometer control (EP control). For each direction of crane motion - up, down, forward, backward, right, left - the controller has a separate push-button used to control the speed and duration of the motion in the direction concerned. The push-buttons used in crane drive systems are generally of the two-position type, in which the first position determines the start of motion in the direction in question and a so-called initial acceleration as well as the maintenance of the velocity at the level attained. The second position determines the increasing of the speed reference at a given rate of acceleration until the maximum speed is reached. Releasing the push-button causes the motor to decelerate in a controlled manner down to zero speed.

In the control mode used by controller 4, the speed reference acceleration input is always activated first and the controller position always corresponds to the value of the speed reference. In the control mode used by controller 5, the switch determining the direction is always turned on first and only then can the speed reference acceleration be connected. The control unit 3 is provided with a monitoring element which senses the order in which the control unit inputs are switched on, i.e. whether the acceleration input in the control port is on when one of the direction inputs is switched on. Fig. 2 shows a flow diagram illustrating the selection of control mode.

If the speed is other than zero, operation continues in the control mode currently in use. If the speed is zero and the acceleration input is on but the direction inputs off, the control mode of the first controller is selected. Similarly, if a direction input is on and the acceleration off, the control mode of the second controller is selected. In other cases, the current control mode is maintained. Thus, the control mode is selected making use of the

order in which the control signals obtained from the controllers are switched on, without using a separate selection switch. The selection logic and the monitoring of the signal states can be implemented in a manner known in itself using techniques belonging to the expertise of a person skilled in the art.

Fig. 3 presents a timing diagram illustrating the selection of control mode when control commands are given in different ways. Curves a) and b) represent the variation of the control signals with respect to time while the curves under c) represent the selection of the control mode on the basis of the control signals in accordance with the selection logic described above. A direction signal 7 issued afterwards while the motor is already running does not affect the control mode. At instant t_2, the direction signal 8 is on but the acceleration is zero, so electronic potentiometer control is selected. Correspondingly, in this case a subsequent acceleration signal 9 has no effect on the control mode.

In this procedure it is naturally necessary to take care that all the controllers and controller positions in each control device are included in the selection process. This prevents simultaneous use of the controller at one control point for a lifting movement and another controller e.g. for a traversing motion.

In the foregoing, the invention has been described by referring to some of its embodiments. However, this presentation should not be regarded as restricting the invention, but the scope of the patent may vary within the limits defined in the following claims.

Claims

1. Procedure for selecting the control mode of at least one controller generating control signals (6-9) which are fed via a control port to a control unit (3) for controlling a crane motor (2), when at least two alternative modes of conrolling the motor are available, at least one of the modes involving control by means of a switch (5) having at least two positions connectable in a certain order, thereby producing corresponding control signals in the control port, and each control mode using at least one control signal common to all modes,
characterized in that

   - the control signals (6-9) fed from all controllers to the control port are monitored by a monitoring element of the control unit (3),
   - the prevailing control situation is determined on the basis of the control signals (6-9) monitored, and
   - the control mode is selected by a selection logic on the basis of the control signals (6-9) and the prevailing control situation.

2. Procedure according to claim 1, **characterized** in that the control situation is determined on the basis of the temporal order of the signals characteristic of the control modes.

3. Procedure according to claim 1 or 2, in which the first position of at least one two-position switch (5) determines the direction of rotation of the motor while the second position determines the acceleration, the signal determining the acceleration being common to two control modes,
characterized in that

   - the control port determining the direction of rotation as well as the control port determining the acceleration are monitored and
   - the first control mode is selected if the control signal (7,8) determining the direction of rotation becomes active first and the second control mode is selected in other cases.

4. Procedure according to claim 1, 2 or 3, **characterized** in that the control mode is not changed while the motor (2) is rotating.

5. Procedure according to any one of claims 1 - 4, **characterized** in that the first control mode is electronically controlled stepless variation of speed and the second control mode is analog stepless variation of speed.

6. Procedure according to one of the preceding claims, **characterized** in that the at least two alternative control modes are implemented in different controllers (4,5).

7. Procedure according to one of the preceding claims, **characterized** in that the at least two alternative control modes are potentiometer control (PO control) and electronic potentiometer control (EP control).

Patentansprüche

1. Verfahren zum Auswählen des Steuerungsmodus zumindest einer Steuerung, die Steuerungssignale (6-9) generiert, die über einen Steuerungsanschluß einer Steuerungseinheit (3) zum Steuern eines Kranmotors (2) zugeführt werden, wenn zumindest zwei alternative Steuerungsarten für den Motor verfügbar sind, wobei zumindest eine dieser Arten die Steuerung mittels eines Schalters (5) betrifft, der zumindest zwei Positionen aufweist, die in einer bestimmten Reihenfolge verbindbar sind, wobei entsprechende Steuerungssignale in dem Steuerungsanschluß generiert werden und jeder Steuerungsmodus zumindest ein Steuerungssignal verwendet, das allen Steuerungsarten gemeinsam ist, dadurch gekennzeichnet, daß

- die Steuerungssignale (6-9), die dem Steuerungsanschluß von allen Steuerungen zugeführt werden, mittels eines Überwachungselementes der Steuerungseinheit (3) überwacht werden,
- die vorherrschende Steuerungssituation auf der Basis der Steuerungssignale (6-9) überwacht wird, und
- der Steuerungsmodus von einer Auswahllogik auf der Basis der Steuerungssignale (6-9) und der vorherrschenden Steuerungssituation ausgewählt wird.

2. Verfahren in Anspruch 1, dadurch gekennzeichnet, daß die Steuerungssituation auf der Basis der zeitlichen Reihenfolge der für die Steuerungsarten charakteristischen Signale bestimmt wird.

3. Verfahren nach Anspruch 1 oder 2, bei welchem die erste Position zumindest eines Zwei-Positions Schalters (5) die Drehrichtung des Motors festlegt, während die zweite Position die Beschleunigung festlegt, wobei das die Beschleunigung bestimmende Signal zwei Steuerungsarten gemeinsam ist, dadurch gekennzeichnet, daß

- sowohl der die Rotationsrichtung bestimmende als auch der die Beschleunigung bestimmende Steuerungsanschluß überwacht werden, und
- der erste Steuerungsmodus gewählt wird, wenn das Steuerungssignal (7, 8) zur Bestimmung der Rotationsrichtung zuerst aktiv wird, und der zweite Steuerungsmodus in anderen Fällen gewählt wird.

4. Verfahren nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß der Steuerungsmodus nicht geändert wird, wenn sich der Motor (2) dreht.

5. Verfahren nach einem der Ansprüche 1-4, dadurch gekennzeichnet, daß der erste Steuerungsmodus die elektronisch gesteuerte stufenlose Veränderung der Geschwindigkeit beinhaltet und der zweite Steuerungsmodus die analoge stufenlose Veränderung der Geschwindigkeit.

6. Verfahren nach einem der vorhergehenden Ansprüche, daß zumindest zwei alternative Steuerungsarten in unterschiedlichen Steuerungen (4, 5) realisiert sind.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die zumindest zwei alternativen Steuerungsarten die Potentiometer-Steuerung (PO-Steuerung) und die elektronische Potentiometer-Steuerung (EP-Steuerung) sind.

Revendications

1. Procédé de sélection du mode de commande d'au moins un dispositif de commande engendrant des signaux de commande (6-9) qui sont envoyés via un port de commande à une unité de commande (3) pour commander un moteur de grue (2), lorsqu'au moins deux modes possibles de commande du moteur sont disponibles, au moins un des modes comportant la commande au moyen d'un commutateur (5) qui a au moins deux positions connectables dans un certain ordre, produisant ainsi des signaux de commande correspondants dans le port de commande, et chaque mode de commande utilisant au moins un signal de commande commun à tous les modes,
caractérisé en ce que :
les signaux de commande (6-9) fournis par tous les dispositifs de commande au port de commande sont surveillés par un élément de surveillance de l'unité de commande (3),
la situation de commande existante est déterminée sur la base des signaux de commande (6-9) surveillés, et
le mode de commande est choisi par une logique de sélection sur la base des signaux de commande (6-9) et de la situation de commande existante.

2. Procédé suivant la revendication 1, caractérisé en ce que la situation de commande est déterminée sur la base de l'ordre temporel des signaux caractéristiques des modes de commande.

3. Procédé suivant la revendication 1 ou 2, dans lequel la première position d'au moins un commutateur à deux positions (5) détermine le sens de rotation du moteur tandis que la deuxième position détermine l'accélération, le signal qui détermine l'accélération étant commun aux deux modes de commande,
caractérisé en ce que :
le port de commande déterminant le sens de rotation ainsi que le port de commande déterminant l'accélération sont surveillés, et
le premier mode de commande est choisi si le signal de commande (7,8) déterminant le sens de rotation devient actif en premier, et le deuxième mode de commande est choisi dans les autres cas.

4. Procédé suivant la revendication 1, 2 ou 3, caractérisé en ce que le mode de commande n'est pas changé pendant que le moteur (2) tourne.

5. Procédé suivant une quelconque des revendications 1 à 4, caractérisé en ce que le premier mode de commande st une variation de vitess continue commandée électroniquement et le deuxième mode de commande est une variation de vitesse continue analogique.

6. Procédé suivant une des revendications précédentes, caractérisé en ce qu lesdits au moins deux modes de commande possibles sont mis en oeuvre dans des dispositifs de commande différents (4,5).

7. Procédé suivant une des revendications précédentes, caractérisé en ce que lesdits au moins deux modes de commande possibles sont une commande par potentiomètre (commande PO) et une commande par potentiomètre électronique (commande EP).

FIG. 1

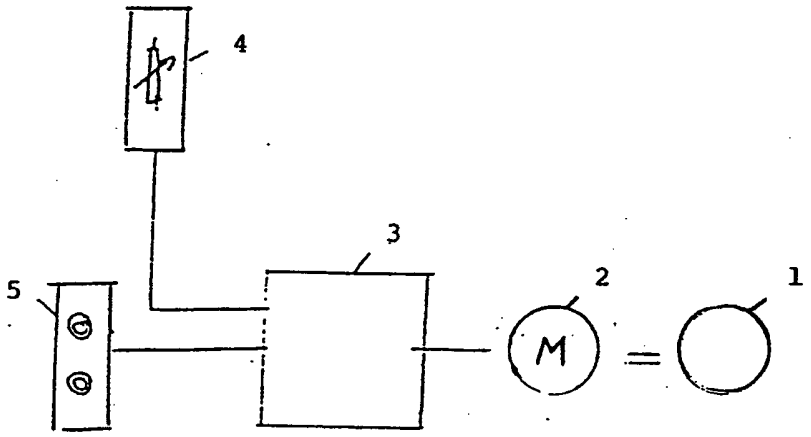
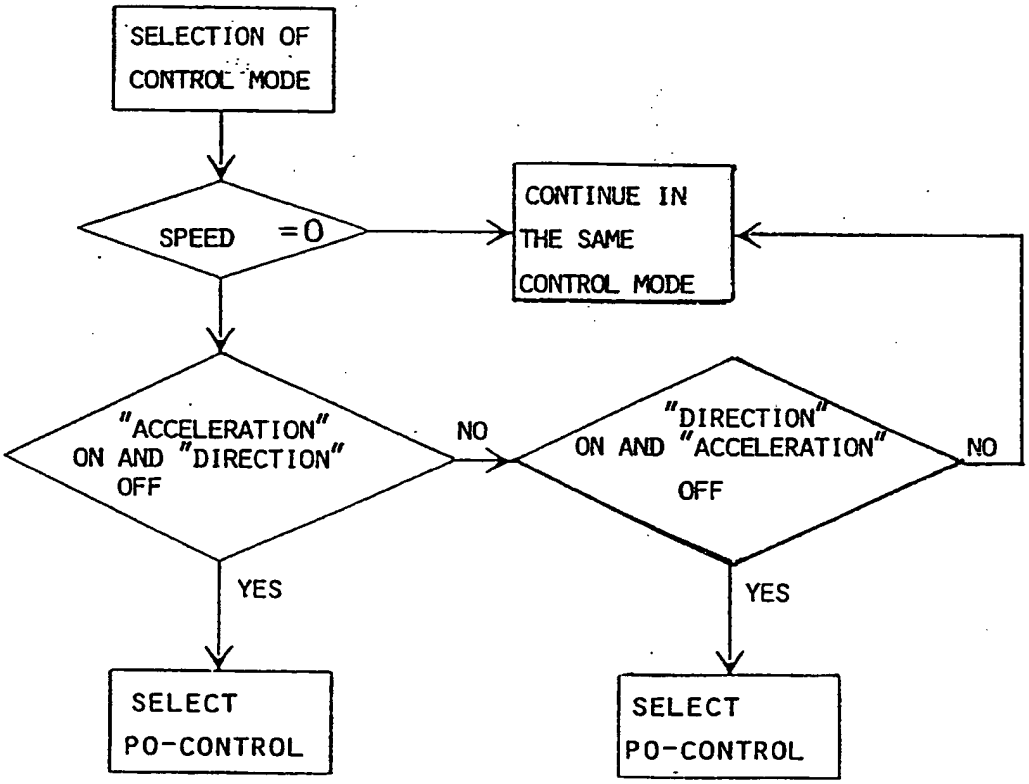


FIG. 2


SELECTION OF CONTROL MODE
SPEED =0
CONTINUE IN THE SAME CONTROL MODE
"ACCELERATION" ON AND "DIRECTION" OFF
NO
"DIRECTION" ON AND "ACCELERATION" OFF
NO
YES
YES
SELECT PO-CONTROL
SELECT PO-CONTROL

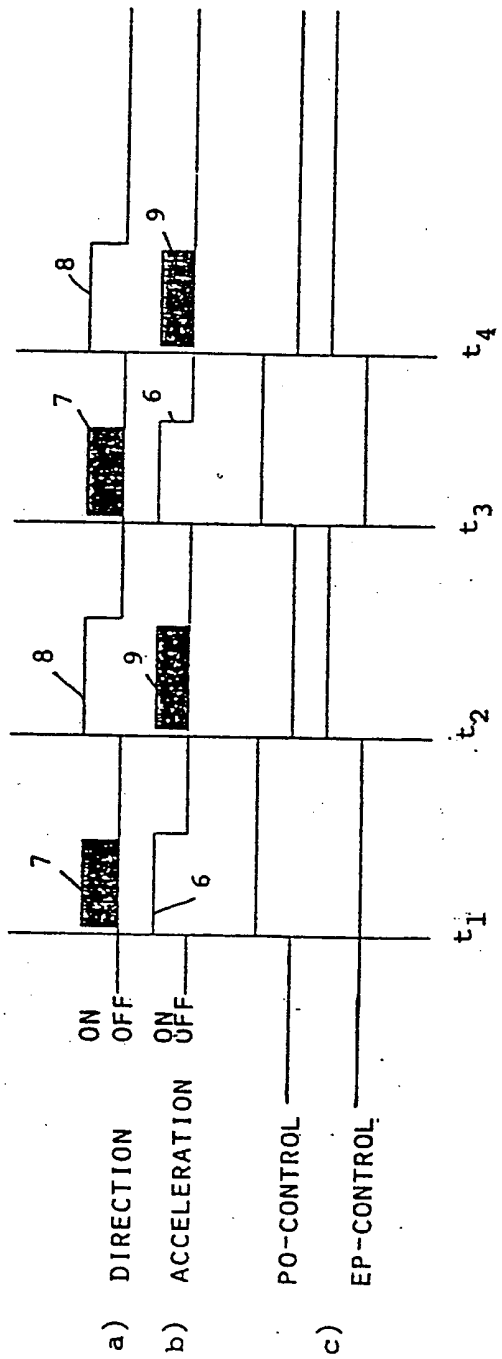

a) DIRECTION
ON
OFF
b) ACCELERATION
ON
OFF
PO-CONTROL
c) EP-CONTROL
6
7
8
9
t_1
t_2
t_3
t_4

FIG. 3